

Discussion Paper

**MINE RECLAMATION FUNDS:
A MECHANISM FOR
ENVIRONMENTAL PROTECTION**

**Ministry of Energy,
Mines and Petroleum Resources**

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MINE RECLAMATION FUNDS

A Mechanism for Environmental Protection

Reclamation in British Columbia

In British Columbia, the satisfactory reclamation of mine sites has been an integral part of mine planning, permitting and monitoring since 1969. The mining industry has responded positively to the Ministry's mine reclamation program and the province has developed a good reputation across Canada and internationally for its commitment to responsible land use and restoring land to productive purposes.

The 1990's present new challenges for mine reclamation. Public expectations for land and resource management are changing. Understanding and awareness of the impacts of mining on land, water and other resources is growing. Research into the scientific basis of reclamation is making new strides. Policies and practices have been updated to respond to and guide these changes. One key change, contained in the new Mines Act, provides for Reclamation Funds to allow new approaches to be taken to reclamation security.

The reclamation of a typical mine site involves the dismantling of buildings and structures and the stabilization and revegetation of mine waste dumps and tailing impoundment areas. Some of this work begins during the mine's operating life and it is usually completed within ten years following closure. The vast majority of the mines in British Columbia follow this typical pattern.

For these mines, reclamation costs are significant but manageable for the mining companies. They can meet the bonding requirements set by government to ensure that proper reclamation occurs and that the public and its resources are protected after mine closure.

However, for the small number of mines which do not follow the "typical" pattern, funding mine reclamation costs is one of the most important outstanding reclamation issues.

This is because these mines present a totally different situation from the typical site. For example, at minesites where acid rock drainage* is occurring, it may be necessary to collect and treat acidic runoff for many years following closure. This cost can be large, it is continuing, and it cannot necessarily be reliably forecast. How can a mining company fund this expense once its mine has closed and cash flow from operations has ceased? How can the province be assured that the company has adequate funds in place to meet its obligation to reclaim the site?

The standard forms of reclamation security accepted by the Ministry, bonds and irrevocable letters of credit, are not practical in situations where there is a significant ongoing cost and where the company responsible does not, once the mine has closed, have sufficient other assets or income to fund the work. It is for these situations that the 1990 Mines Act provided for a new form of security: Mine Reclamation Funds.

The attached technical paper "Mine Reclamation Funds", sets out a proposal for the administration of such funds. The proposal is designed to ensure that two key needs are met:

- there is a source of income to pay for the long-term reclamation program; and
- there is the full security required by the Province to see that undue risk is not borne by the public.

* Acid Rock Drainage results from the interaction of sulphides in rocks with oxygen and water from the environment to produce sulphuric acid. Acid rock drainage occurs naturally; it may also result from the exposure of rocks during construction activities. The main cause, however, is mining. Because this paper deals with mines and mine reclamation, the term 'acid mine drainage' will generally be used.

The paper was commissioned by the Ministry and prepared by Professors R. Giammarino, A. Kraus and J. Zechner of the Faculty of Commerce and Business Administration at the University of British Columbia.

Following distribution of the paper and a process of consultation, the ministry proposes to circulate draft regulations and Fund agreements for further comment and discussion.

Mine Reclamation Funds: The Basic Concept

Mine Reclamation Funds are being developed to serve as an acceptable form of security for companies which face a significant, long-term post-closure reclamation cost that they would not otherwise be able to finance. This need is especially strong for companies based on a single mine, since diversified companies may well have other ongoing income sources available to pay for the reclamation. For this reason, the case is sometimes referred to as the single-mine-company case. However, there may be other situations where use of Mine Reclamation Funds would be warranted.

The basic idea is simple. The single-mine-company has a post-closure reclamation obligation but, after closure, no operating cash flow with which to fund that work. At the same time the province requires security to provide assurance that the required reclamation will be carried out. Company payments into a mine-specific Reclamation Fund, whose earnings are expected to provide for the costs of the reclamation program, can satisfy both of these objectives.

A Mine Reclamation Fund is, in effect, an agreement between the province and the mining company that allows the funds set aside by the company to be used to meet the province's security requirements. The degree of security afforded the province depends on the terms of the agreement for creating and managing a fund.

Fund Objectives: Risk Management

A Mine Reclamation Fund is intended to provide for the costs of mine reclamation over what may be a very long period. Inevitably there will be uncertainty: the nature of the reclamation problem may turn out to be better or worse than expected; costs will be affected by inflation and by technological change; and the fund's investment income will depend on national and international economic conditions.

Yet in the single-mine company case, there is only one opportunity—before the mine closes—to set aside an amount sufficient to meet the company's objectives for a reclamation program and to meet the province's objective of adequate reclamation security. If the amount is insufficient, the province will be called upon to bear the costs of completing the reclamation program.

Because of this, the risks facing the province are asymmetric, or not evenly balanced. That is, if the amount in the Fund is too low, the government may end up paying reclamation costs that were the responsibility of the mining company. On the other hand, if the amount in the fund is set too high, excess income will be generated and it would be possible to pay a refund to the company. For government, the path of least risk would always favour setting the security on the high side.

However, if government consistently chooses to set security requirements on the high side, this too-conservative approach will result in an unjustifiable addition to mining costs and will thus be a disincentive to investment in mining in the province at sites where long-term reclamation costs can be foreseen. It is important that mines which can cover all of their costs, including their environmental costs, not be discouraged. A balance is needed to ensure that both the public's interest in the many benefits of mining and its interest in long-term environmental quality are met.

The Ministry proposes the following principles for managing the risks and achieving an acceptable balance:

- each mine should be assessed individually and the security set to reflect the costs and risks associated with reclaiming that site;
- estimated costs should be based on careful engineering and technical studies. These should be accompanied by formal risk assessments taking into account the probabilities and consequences of alternative scenarios;
- agreements should be structured to give mining companies incentives to remain actively involved in managing their reclamation programs, to control costs and to develop innovative technical solutions to reclamation challenges;
- because of the range of uncertainty with which the funds are designed to deal, and the resulting range of possible outcomes, the security should be set so that the government has assurance that reclamation will be performed satisfactorily;
- reclamation obligations and security agreements should be designed to ensure that the companies have no incentive to act (or fail to act) in ways that might shift risks to the province. That is, any residual risk borne by the province should reflect no more than 'pure chance' and be in proportion to the similar risks it bears as an 'insurer of last resort' in other social circumstances.

Fund Structure

The proposed fund structure is designed to meet the following criteria:

- it should be actuarially fair to both the government and the mining company;
- it should recognize and correct for the asymmetric nature of the risk faced by the government which would otherwise tend towards inappropriately conservative

security policies—or it should recognize and correct for the asymmetric nature of the risk faced by the government by compensating government for its share of risk borne under an agreement;

- it should be capable of accommodating change but in a fair and well-defined manner;
- it should encourage companies to consider innovative approaches to solving reclamation problems.

The Mine Reclamation Fund, operated in accordance with the following procedural rules and parameters, satisfies these needs:

- the initial amount in the Mine Reclamation Fund is calculated as the expected present value of future **reclamation costs**: the cost data is generated by an impartial process; the present value is calculated using the historic rate of return on the type of **investment policy** both parties agree will be followed by the fund;
- a percentage **margin** is added to the above amount: this margin will reflect the amount of uncertainty that exists about reclamation costs as well as other features of the fund structure;
- the Fund, which is owned by the company, is invested according to the agreed policy; the yield on investments is credited to the fund which in turn pays for the necessary reclamation on the site;
- periodically, perhaps annually, the surplus or deficit in the fund is calculated: this will involve a comparison of expected versus realized investment returns and reclamation costs; and will allow a reassessment of expected future reclamation costs;

- if there is a shortfall, the company is obliged to inject additional amounts to bring the Reclamation Fund up to the required level, including margin. If the company fails to do this, it forfeits its claim on the Fund. If there is a surplus over and above the required margin, the surplus may be shared in accordance with an agreed **sharing formula** based on the risks assumed.

Government Participation

The amount required in the Fund is calculated so that **the expected value of provincial government contributions is zero**: the prospect of having to contribute to make up a deficit not covered by the company is exactly balanced by the prospect of the province's agreed share of any surpluses.* The procedure for performing these calculations is described in full in the technical paper which models the operation of the Fund for a variety of cases.

How does this fund meet the above criteria?

First, it is actuarially fair in that the expected value of payments by the government is zero, and therefore, the payments made by the company will equal the expected value of reclamation costs (including fund administration costs).

Second, it corrects for the asymmetric risks that would otherwise be faced by the government: if the government accepts a risk it is compensated for this by becoming entitled to a share of any surpluses.

Third, it is flexible. There are a number of combinations of parameters that will achieve the objective. Some companies may not wish the government to share in surpluses; in that case, the margin requirement (and, hence the size of the fund) would be set higher to compensate the government for the higher risk that decision entails.

*Thus if there is a government share in any surplus, it would be compensation for specific elements of risk assumed by agreement with the company in establishing the Fund. An alternative for companies would be to seek specific risk coverage from the insurance industry as a means of reducing the total amount required in the Fund itself.

Fourth, the structure is flexible in that over time it is possible to change or adjust parameters to keep the fund in proper balance. For example, it might be considered advantageous to switch to a more, or less, risky investment portfolio: this can be done in a fair and objective manner by making some compensatory change in the margin requirement or sharing formula.

Finally, the model provides incentives for innovation and cost-minimization since, by remaining actively involved and achieving success in managing the fund and the reclamation program, the company will produce and share in future fund surpluses.

It was noted earlier that there is only 'one chance to get it right'. That is largely true. However, with this proposed fund structure there is tolerance for forecast error and opportunities for adjustments. In particular, the mining company has an incentive to make up deficits in the fund in order to retain its right to share in future surpluses. Provided that forecast errors are random and are not large in relation to the margin, the fund structure can accommodate them.

Estimating Reclamation Costs

The situations in which Mine Reclamation Funds will be used will usually involve large sums of money, long timeframes and, therefore, even with the best possible decision-making, a potential for error. How can the government fairly be held accountable to the public for the decisions it makes in accepting and managing these risks?

The fund structure gives a clear and explicit procedure for assessing and managing the risks faced by the government in setting its security requirement. However, the model will provide reliable guidance only if present and future reclamation costs are estimated in a technically and statistically sound manner and if the risks of cost under-runs or over-runs are well understood. There is no certain procedure to assure this. Rather, the ministry is committed to using the best available professional advice on costs and risks and to the full disclosure of the basis for its cost/risk assessments. In addition, the ministry is prepared to utilize the services of

mediators and facilitators in order to understand and resolve differences of opinion on these technical matters and to build public and industry confidence in the impartiality of the process

Fund Management

A Mine Reclamation Fund serves two purposes simultaneously. It is, firstly, a source of income to the mining company which is used to pay for ongoing reclamation. Secondly, it serves as security to the province. Considered simply as a company fund, the province has no interest in it per se—as long as the company is meeting its reclamation obligations satisfactorily. However, considered as security, the province is very much concerned with how the fund is managed. Since in the case of a single-mine-company there is no other source of funding for the reclamation program, the Province must be assured that future reclamation costs can be met out of projected fund income.

The ministry believes that the dual nature of the fund can best be recognized by entering into an Agreement with the company. This Agreement would recognize and protect the company's interests without detracting from the fund's value as security or fettering the statutory discretion of the Minister under the Mines Act.*

This Agreement would provide:

- a process for determining reclamation costs and the fund amount; for calculating (and sharing or making up) future surpluses and deficits; and for resolving differences among the parties on these matters.
- a process for verifying the eligibility of reclamation expenditures made from the fund, which may in addition, be required for tax reasons.

*Section 10 of the Mines Act contains general provisions governing reclamation security; and Section 12 of the Act contains the specific provisions governing reclamation funds.

- for the selection of investment policy and the appointment of a fund Trustee and investment manager.

The government has, by law, final authority on the amount of the Mine Reclamation Fund and the power to take action in the event the value of the security is compromised. Subject to these conditions, the ministry believes that a mining company will have a strong interest and legitimate role in the management of a fund.

Tax Treatment of Reclamation Funds

Expenditures on reclamation, like any other cost of mining, are deducted from mine revenue in the calculation of net income subject to federal and provincial corporate income tax. However, once the mine has closed, its revenues have ceased, and the three-year tax carry-back period has expired, the right to deduct post-closure reclamation costs is of no value to the company. This is a significant tax disincentive to mine reclamation. But it can be removed if contributions to Mine Reclamation Funds are deductible at the time they are made during the mine's operating life. Such a change in the tax legislation will have no appreciable impact on the present value of government tax revenues, but could make a critical difference to the acceptability and success of the Funds from an industry perspective.

The new British Columbia Mineral Tax Act already contains such a provision.

An amendment to the Income Tax Act of Canada to allow the deduction is presently being considered by the federal authorities. If approved, it would apply to the calculation of Federal and British Columbia corporate income tax.

The fund management arrangements are intended to satisfy the income tax authorities that Mine Reclamation Funds cannot be used as a tax avoidance scheme. The ministry will consider modifications of these arrangements in order to address any concerns of Revenue Canada that may arise during their evaluation of the proposal.

Avoiding 'Double-Bonding'

Although the Ministry of Energy, Mines and Petroleum Resources is responsible for mine reclamation, other British Columbia ministries, notably the Ministry of Environment, have responsibilities under their legislation which may require the posting of security. The Waste Management Act is a good example.

The Ministries of Environment and Energy, Mines and Petroleum Resources have already agreed to develop a protocol agreement under which both ministries' security requirements respecting mine reclamation of both ministries would be amalgamated into a single security instrument. This protocol could be extended and amended to include other ministries if required.

The Ministry of Environment is now undertaking a detailed review of this Mine Reclamation Fund proposal.

Implementation of Funds

Mine Reclamation Funds address a critical public policy requirement: the need for a security instrument suited to the situation where a single-mine-company faces a significant long-term, post-closure reclamation cost. Fortunately, these situations are few in number. Even more fortunately, developments in the field of acid mine drainage prediction and prevention should reduce the incidence and the significance of this concern in the future. But, at least for now, the problem must be addressed with the best technical tools available.

The ministry believes that this proposal to establish Mine Reclamation Funds represents a balanced, fair, innovative, and responsible approach to this serious issue. The Ministry looks forward to consultations with all those who have an interest in this matter and to the further development and refinement of Mine Reclamation Funds.

For further information on British Columbia's Mine Reclamation Funds or to participate in the consultation process, please contact:

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MINE RECLAMATION FUNDS

Final Report

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The Mineral Policy Branch

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and Petroleum Resources

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Chapter 1

Executive Summary

Although mining activity can affect the environment in various ways these impacts can usually be mitigated through environmental controls and reclamation technologies. Reclaiming a mine site involves a series of costs over time and responsibility for those costs is a liability of the mining company. In the event that the company defaults on its obligation, the cost of the required reclamation is born by the public through the Provincial Government.

This particular liability can differ from most others, however, in that cash outflows can be incurred over a number of years (possibly in perpetuity in the case of acid mine drainage (AMD)) after the operations of the mine have ceased. This feature of mitigation costs raises three related problems.

- i) The ability of the mine to support mitigation expenses is drastically reduced once the economic life of the mine has ended. Since the life of certain mitigation costs can be expected to exceed the life of the mine, the possibility that the company will be unable to make the required

payments arises.

- ii) The fact that the company may not be able to fund future mitigation costs lowers the incentive for the firm to try to minimize such costs.
- iii) Any mitigation costs that are not met by the company must be met by the people of British Columbia, either through government funding of the mitigation costs or through the negative externalities generated by environmental damage.

The Province of British Columbia has provided for the establishment of mine-specific reclamation funds (referred to as the "Fund"), which will serve as security for mine reclamation obligations, in Section 12 of the Mines Act (S.B.C. 1989 C.56). The objective of the Fund is to overcome the problems set out above, and thereby facilitate satisfactory reclamation. It is expected that single-mine companies with long lived reclamation obligations will be interested in establishing such Funds.

Fund contributions will be made either before or during the operation of the mine. The Fund will have a life that matches the life of the mitigation costs and hence is not bounded by the economic life of the mine. At the same time, the Fund structure will be such that if the current value of the Fund is deemed to be more than sufficient to meet the mitigation costs, then some portion of the surpluses will be distributed to the company. In this way the company has the ability to share in any mitigation cost savings that

it produces. Finally, it is a requirement of the Fund that the Province be appropriately compensated for the risk that it is required to bear.

Having considered a number of alternative Fund structures, we recommend the following.

- Fund contributions and disbursements should be based on a benchmark figure which we refer to as the mitigation cost value or MCV. This figure is the present value of the expected mitigation costs. The risk of technological change as well as the investment risk generated by the Fund's portfolio of financial assets is accounted for in computing this value.
- The company will contribute an initial amount to the Fund which will be set at a fixed percent margin above MCV. In return the company receives a claim to the Fund which we will refer to as a Fund ownership share (FOS). The FOS is a financial asset and ownership is transferable once the mine has ceased operations.¹
- Each year, an end of year Fund size is computed as the previous year's balance plus the realized investment income, minus actual mitigation costs. In addition, the MCV is recomputed each year taking into account changes in market conditions and technological changes.

¹One of the objectives of the Fund is to provide an incentive for companies to reduce the ultimate mitigation costs whenever possible by providing it with a share in any savings. This incentive would be eliminated if ownership of the FOS were transferred prior to the mine ceasing operations and it is for this reason that such a transfer would be prohibited.

- If the realized Fund size exceeds the MCV plus margin at the end of the year, then the surplus is shared by the owner of the FOS and the Province according to a predefined sharing rule.
- If the realized Fund is less than the MCV plus margin, then the owner of the FOS is required to contribute sufficient funds to bring the Fund up to the MCV plus margin. Failure to do so results in the extinction of the FOS and the Province becomes the sole claimant to the Fund.
- The Fund is terminated when the MCV reaches zero and at that point a liquidating dividend is paid to the owner of the FOS and the Province.

This structure accomplishes the objectives set out above. The margin requirement provides a reasonable level of assurance that the mitigation costs will be met at a significantly lower Fund size than would be necessary if the FOS procedure were not adopted. This is due to the fact that the FOS is a valuable asset and its value is independent of the economic viability of the mine involved. As a result, the Province has greater assurance that the owner of the FOS will contribute to future mitigation costs if necessary. Moreover, the remaining possibility that the Province will be required to contribute funds in the future is exactly offset (on an expected value basis) by the possibility that it will share in future surplus disbursements. Because the value of the FOS is increased with decreases in the mitigation costs, the company benefits from actions which reduce future mitigation costs *even if*

the company is no longer in existence when the cost savings are realized.

At the same time the structure of the Fund provides the company with considerable flexibility. To some extent, the initial contribution to the Fund and the sharing rule are substitutes so that the company can lower the initial cash requirements at the expense of having a smaller claim on future surpluses. In addition, the FOS can be sold to a third party once the mine has ceased operations and the proceeds used to pay a liquidating dividend to the company.

Another feature of the proposed framework is that the terms of the Fund can be computed for any particular asset mix. This allows the company and the Province to adjust the investment portfolio of the Fund while ensuring that the objectives of the Fund will continue to be met.

Chapter 2

Objectives and Fund Structure

Although mining activity can impact the environment in various ways these impacts can usually be mitigated through environmental controls and reclamation technologies. Reclaiming a mine site involves a series of costs over time and responsibility for those costs is a liability of the mining company. In the event that the company defaults on its obligation, the cost of the required reclamation is born by the public through the Provincial Government.

This particular liability can differ from most others, however, in that cash outflows can be incurred over a long number of years (possibly in perpetuity in the case of acid mine drainage (AMD)) after the operations of the mine have ceased. This feature of mitigation costs raises three related problems.

- i) The ability of the mine to support mitigation expenses is drastically reduced once the economic life of the mine has ended. Since the life of certain mitigation costs can be expected to exceed the life of the mine, it is possible that those mitigation payments may not be made

by the company, particularly if the depleted mine was the company's main source of income.

- ii) The fact that the company may not be able to fund future mitigation costs lowers the incentive for the firm to try to minimize such costs.
- iii) Any mitigation costs that are not met by the company must be met by the people of British Columbia, either through government funding of the mitigation costs or through the negative externalities generated by environmental damage.

The Province of British Columbia has provided for the establishment of mine-specific reclamation funds (referred to as the "Fund"), which will serve as security for mine reclamation obligations, in Section 12 of the Mines Act (S.B.C. 1989 C.56). The objective of the Fund is to overcome the problems set out above and thereby to facilitate satisfactory reclamation. It is expected that single-mine companies with long lived reclamation obligations will be interested in establishing such Funds.

Fund contributions will be made either before or during the operation of the mine. The Fund will have a life that matches the life of the mitigation costs and hence is not bounded by the economic life of the mine. At the same time, the Fund structure will be such that if the current value of the Fund is deemed to be more than sufficient to meet the mitigation costs, then some portion of the surpluses will be distributed to the company. In this way

the company has the ability to share in any mitigation cost savings that it produces. Finally, it is necessary that the structure of the Fund reflect the risk that the Province faces as the ultimate guarantor of reclamation performance. Elimination of all risk faced by the Province is not practical since it would require an extremely large Fund to cover the most extreme conceivable contingency. As a result, the structure of the Fund must recognize the risk that remains and compensate the Province accordingly.

2.1 Fund Structure

The principal requirement of the Fund is that it be a vehicle through which contributions are made on the basis of expected mitigation costs; however the magnitudes of these costs are often difficult to predict. Furthermore, since the Fund is likely to be invested for a long period of time, there will be investment risk. Consequently, the ability of the Fund to meet the actual mitigation costs that arise will depend on those two sources of risk.

There are two approaches that can be used to deal with this risky situation. One is simply to value the mitigation cost liability, recognizing the risks involved, and transfer the liability from the company to the Province in exchange for a fee which would be the size of the Fund. Subsequent deficiencies in the Fund are offset by Provincial government contributions and surpluses would be distributed to the Province. The second is to adopt a dynamic approach in which company involvement in reclamation continues

for some time.

There are, however, two problems with the first approach. First, it is very difficult to fully characterize the nature of the financial and technical risks faced by the Fund. On the one hand, although the investment risk is something that can be dealt with since the instruments and institutions have a long history which can be used to form the basis of a projection into the future, forecasts for long periods of time are difficult to make. On the other hand, however, the nature of the costs generated by environmental damage are, in many cases, not well known. Hence, any assessment of the risk involved is at best tentative and must be reassessed regularly. The second problem is that the mitigation costs can be affected by the actions of the mine operator. If the mitigation cost liability is completely removed, then the operator has no incentive to minimize costs.

Both of these concerns argue for the second approach, which is a dynamic Fund structure. Our recommendation is that the following general structure be adopted.

- The Fund will be established by the company. In establishing the Fund, the company will receive a Fund Ownership Share (FOS). The owner of the FOS will receive part of any surpluses generated by the Fund but may also be required to make future contributions to the Fund.
- Contributions to and disbursements from the Fund are made at the end of each 'period'. The length of each period (i.e., whether a year,

a quarter, a month, etc.) is established separately for each mine. The factors that enter into the determination of the length of the review period are discussed below.

- The Fund contributions and disbursements will be based on a benchmark figure which we refer to as the mitigation cost value or MCV. This figure is essentially the present value of the expected mitigation costs. The risk of technological change as well as the investment risk generated by the Fund's portfolio of financial assets is accounted for in computing this value.
- The initial amount of the Fund, contributed by the company, will be equal to the MCV plus a specified amount (the margin) of the MCV (e.g. if 10% were specified, then the Fund would be set at 110% of the MCV). The company will receive a FOS in return for establishing the Fund. The FOS is a financial asset and ownership is transferable once the mine has ceased operations.
- Each period an end of period Fund size is computed as the previous period's balance plus the realized investment income, minus the actual mitigation costs. In addition the MCV is recomputed each period taking into account changes in market conditions, site conditions and technology changes.
- If the realized Fund size exceeds the MCV plus margin at the end of

the period then the surplus is shared by the owner of the FOS and the Province according to a predefined sharing rule.

- If the realized Fund is less than the MCV plus margin, then the owner of the FOS is required to contribute sufficient funds to bring the Fund up to the MCV plus margin. Failure to do so results in the extinction of the FOS and the Province becomes the sole claimant to the Fund.
- The Fund is terminated when the MCV reaches zero and at that point a liquidating dividend is paid to the owner of the FOS and the Province.
- The length of the period after which the required fund size is to be recalculated should reflect an optimal balancing of the costs and benefits involved. The cost of a shorter period is that it implies more reviews and therefore greater review costs. The benefit of a more frequent review is that the expected required payments by the Province are decreased. These costs and benefits will in turn be influenced by the volatility of rates of return and mitigation costs. In our simulations we assume that the Fund size is recalculated at the beginning of each year.¹

This structure meets the objectives of the Fund. We wish to point out that the dynamic nature of the proposed Fund structure lowers the risks to the mining company as well as to the Province significantly. To see this, we

¹Annual recalculation corresponds to current reclamation reporting requirements.

emphasize that forecasts of rates of return as well as mitigation costs over very long horizons such as 100 years cannot be made with high accuracy. However, because of the dynamic adjustments implicit in the proposed Fund structure, the adverse impact of errors in the forecasts in rates of return and mitigation costs is greatly reduced. If, say, future realized rates of return turn out to be higher than the forecasted rates of return, then, at the end of each period, the company receives the predefined share of the implied surpluses. The same is true if mitigation costs turn out to be lower than expected. This point is illustrated in Section 8 in Chapter 3 of this report (Tables 8 and 9).

In addition, the margin requirement provides a reasonable level of assurance that the mitigation costs will be met at a significantly lower Fund size than would be necessary if the FOS procedure were not adopted.² This is due to the fact that the FOS is a valuable asset whose value is independent of the economic viability of the mine involved. Hence, the owner of the FOS has a financial incentive to avoid the loss of this valuable asset by making further contributions as required. As a result, the Province has greater assurance that the owner of the FOS will contribute to future mitigation costs if necessary so that the expected contributions by the Province are reduced. Moreover, the remaining possibility that the Province will be required to contribute funds in some cases is exactly balanced by the possibility that it will share in future surplus disbursements in other cases.

²This point is illustrated in Chapter 3 below.

Because the value of the FOS is increased with decreases in the mitigation costs, the company benefits from actions which reduce future mitigation costs *even if the company is no longer in existence when the cost savings are realized*. To illustrate, suppose that, just prior to the mine closing, the company can take an action which will reduce mitigation costs several years later. Suppose that when the mine closes the company wishes to wind up and pay a liquidating dividend. One of the assets of the mine will be the FOS which will have a value roughly equal to the size of the Fund minus the discounted expected future reclamation costs. Since these reclamation costs have been reduced by the action, the price that will be received for the FOS will be increased by the cost saving involved. Therefore, the owners of the FOS when the decision is made benefit in that their liquidating dividend is increased by the cost saving.

At the same time the structure of the Fund provides the company with considerable flexibility. To some extent, the initial contribution to the Fund and the sharing rule are substitutes so that the company can lower the initial cash requirements at the expense of having a smaller claim on future surpluses.³ In addition, the FOS can be sold to a third party once the mine has ceased operations and the proceeds used to pay a liquidating dividend

³The extent to which the initial contribution can be lowered is, however, limited by the fact that, as the share of surpluses paid to the company is diminished, the incentive to efficiently reduce expected mitigation costs is also reduced. It is also true that, for a given review period, the risk to the province increases. For both of these reasons a minimum sharing rule should be set.

to the company.

Another feature of the proposed framework is that its terms can be computed for any particular asset mix. This allows the company and the Province to adjust the investment portfolio of the Fund while ensuring that the objectives of the Fund will continue to be met.

We apply the recommended Fund structure in detail to the hypothetical case outlined below.

Chapter 3

Fund Size Determination

3.1 Overview

In this chapter we calculate the initial Fund size for the hypothetical case in which the annual costs of the site reclamation are expected to be \$1 million. Underlying the following approach is the assumption that the required Fund size will be estimated annually. Thus, at the beginning of each year, the present value of the expected cost of reclaiming the site is estimated. The details of estimating future discount rates are given in Section 3.3. The required Fund size is then equal to the MCV (present value of the expected costs) plus the margin. That is, if the present value of the costs is \$30 million and the margin is set at 10%, then the required size of the Fund is \$33 million.

If the Fund's size exceeds the required level, a percentage of the difference is paid out to the company. If the Fund's size is below the required level, the company is asked to make an additional payment to bring the Fund's size to the required level. If the Fund's size before this payment exceeds the present

value of the expected costs, we assume the company will always make the required additional payment. In this case it is in the company's interest to retain its FOS claim. If the Fund's size before the payment falls significantly below the present value of the expected costs, the company may choose to default on the required payment and thereby give up its FOS and any future claim on Fund surpluses. In the latter case, the Province takes over the Fund along with all future deficiencies and surpluses.

3.2 Asset Mix

We base the numerical analysis of our recommended method on the assumption that the assets of the Fund would be invested equally in Canadian Treasury Bills, Canadian Government Bonds and Canadian equities. This represents diversification across the major Canadian asset groups which will tend to reduce Fund risk.

In addition to these traditional investments, we note the recent introduction of Index-Linked Mortgages (ILMs), guaranteed by the Central Mortgage and Housing Corporation (CMHC). These ILMs have a maturity of 30 years and currently offer real rates of return of 4.5% to 5% (net) over their term. Although the principal amount invested in ILMs is effectively insured against default, there are significant possibilities that the promised real rate of return will not be earned for the full term to maturity. To see this, it is necessary to note some specific details about these instruments. The ILMs are issued

to finance co-operative housing under the Federal Co-operative Housing Program. Under this program, non-profit housing co-operatives may obtain 100% debt financing. Thus, the co-operative may begin with zero equity. In the event of an economic downturn, a significant drop in incomes and real estate values will then render the co-operative's equity negative and the members will default on the mortgage. In such a case, the CMHC will pay off the principal of the mortgage. In fact then, the ILM is likely to be prepaid in exactly the circumstances when available real rates of return are depressed. Thus, the ILMs have an indirect prepayment option to the borrower which we feel greatly reduces their suitability as a means of guaranteeing high real rates of return. In addition, the lack of a secondary market for the ILMs limits the flexibility for paying out Fund surpluses to the company.

3.3 Forecasts of Future Discount Rates

We estimated future rates of return in the following manner. We estimated the long-run mean real return¹ and the historical speed of convergence to this long-run mean using realized real rates of return since 1954 on an equally weighted mix of Canadian Treasury Bills, Canadian Government Bonds and Canadian equities. Movement toward the long-run mean for this particular asset mix depends on the current real rate level through the following

¹The real rate is the realized nominal rate less the realized inflation rate, as measured by changes in the CPI.

relationship

$$R_t = 0.0245 + 0.105R_{t-1}$$

where R_t denotes the continuously compounded real rate of return on an equally weighted portfolio in year t . The parameters of this equation are those which best fit the history of real rates of return since 1954. The long-run real rate of return in our rate of return forecast (compounded annually) matches the historical average of 3.02%.

To forecast future real rates of return from a given current level, the current rate is substituted for R_{t-1} in the above equation and the calculated value of R_t is the forecast for the following year. Then this forecast is substituted in the right-hand side of the equation and a forecast for a further year is produced. Repeating this procedure produces a series of forecasts for all future years.

3.4 Probability Distribution of Future Costs

Our data on future annual mitigation costs are based on a hypothetical probability distribution which has an expected cost per year of \$1 million. The cumulative distribution is depicted in figure 3.1.

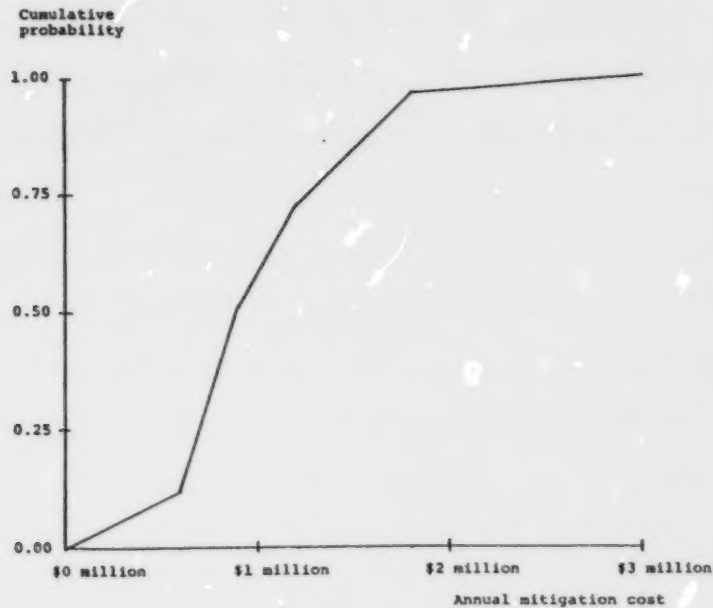


Figure 3.1: Cumulative Distribution of Mitigation Costs

3.5 Calculation of the Initial MCV

To obtain a series of real rates of return, we take a starting value of 6.19% which corresponds to the realized real rate of return on the equally weighted

asset mix in 1988.² The future rates of return are then calculated on the basis of the historical rate of return process estimated according to the equation in Section 3.4. For example, for the years 1988 to 1993 the following rates of return were used

<i>Year</i>	<i>Rate</i>
1988	6.19%
1989	3.37%
1990	3.05%
1991	3.02%
1992	3.02%
1993	3.02%

The expected annual mitigation cost from the probability distribution described above is \$1.00 million (in constant 1988 dollars). Using the forecasted discount factors given above, the present value of expected costs is \$33.50 million. This number is the initial MCV and is used in the numerical simulations described below.

3.6 Simulation of Fund Performance

To analyze the effects of our proposed method to the company and the Province, we performed an extensive numerical simulation of Fund results for different interest rate paths and mitigation costs. We consider margin percentages ranging from 0% to 30%. For each future year of the Fund's

²This corresponds to the realized market rate for 1988 on the equally weighted asset mix. The original statement of the problem to be addressed specified the use of 1988 as a starting value for our forecasts.

operation, the results depend on the realized rate of return and the realized mitigation cost for that year. We describe below how we generate the realizations of rates of return and mitigation costs and the resulting payments into and out of the Fund each year.

We assume that the mitigation cost in the first year equals the mean of the distribution described in Section 3.4. To generate the costs for succeeding years, we drew a value from the probability distribution and assumed that the costs moved linearly to that value over six years. For example, if a long-run value of \$1.5 million was drawn from the distribution, then the annual costs would be as follows

<i>Year</i>	<i>Cost</i>
1993	\$1.00 m
1994	\$1.10 m
1995	\$1.20 m
1996	\$1.30 m
1997	\$1.40 m
1998 & on	\$1.50 m

The path of real rates of return was drawn from the historical frequency distribution of real rates since 1954. The realized rate of return for year t equals the forecast given by the equation in Section 3.3 plus a random deviation based on the historical variance of realized rates.

Each year the Fund is credited with earnings based on the realized rate of return and pays out the realized cost for that year. Then the required Fund size to begin the next year is calculated. This is done by using the current

realized cost as the estimated annual cost from then on and forecasting a series of expected future real rates using the method described earlier with that year's realized rate of return as a starting value. The resulting MCV times one plus the margin percentage gives the required Fund size for the beginning of the next year.

If the actual Fund size exceeds this required size a percentage of the difference is paid out to the company. The remainder of the excess is paid to the Province. If the required Fund size exceeds the actual Fund size, the company must make a new contribution to the Fund equal to the deficiency. If the deficiency is smaller than a critical level (generally 10% of the required Fund size), then we assume that the company makes the payment but if the deficiency exceeds this critical value, the company is assumed to default on its obligation and give up its FOS. In the event of default, no further payments into the Fund are made by the company, nor are any future surpluses paid to the company and so all future deficiencies and surpluses are paid or received by the Province. Following the steps described above, we generate a series of cash flows to the company and the Province, corresponding to each cost path and rate of return path drawn from the distributions.

3.7 Simulation Results

We have simulated Fund results under four alternative assumptions about the percentage shares of surpluses going to the company and the Province:

100% to the company and 0% to the Province, 90% to the company and 10% to the Province, 80% to the company and 20% to the Province and 70% to the company and 30% to the Province. For each sharing rule we considered four alternative margin percentages: 0%, 10%, 20% and 30%. For each of the sixteen combinations of sharing rule and margin percentage we simulated 500 histories of Fund performance, each consisting of 100 years of mitigation costs and rates of return.³ We recorded the average payments by year for the company and the Province and the present value of these average payments. The tables below show the results of the simulations along with the initial Fund size for each case.

³The number of 500 simulations reflects a tradeoff between the accuracy of the results and computing costs. For some scenarios we have performed 10,000 simulations and found that the results - although more accurate - were not significantly different from the results based on the smaller number of 500 simulations. The 100 year horizon is used for computational ease. Extension of the horizon would not significantly alter the present values.

Table 1.

Sharing rule: Company 100%, Province 0%

<i>Margin</i>	<i>Initial Fund Size</i>	<i>PV to Company</i>	<i>PV to Province</i>
0%	\$33.5 million	\$5.7 million	-\$6.2 million
10%	\$36.9 million	\$7.3 million	-\$2.9 million
20%	\$40.2 million	\$9.6 million	-\$2.1 million
30%	\$43.6 million	\$11.0 million	-\$0.8 million

Table 2.

Sharing rule: Company 90%, Province 10%

<i>Margin</i>	<i>Initial Fund Size</i>	<i>PV to Company</i>	<i>PV to Province</i>
0%	\$33.5 million	\$5.2 million	-\$4.2 million
10%	\$36.9 million	\$6.4 million	-\$2.0 million
20%	\$40.2 million	\$6.5 million	-\$0.7 million
30%	\$43.6 million	\$8.4 million	\$1.2 million

Table 3.

Sharing rule: Company 80%, Province 20%

<i>Margin</i>	<i>Initial Fund Size</i>	<i>PV to Company</i>	<i>PV to Province</i>
0%	\$33.5 million	\$4.8 million	-\$3.8 million
10%	\$36.9 million	\$4.1 million	-\$0.6 million
20%	\$40.2 million	\$5.1 million	\$1.9 million
30%	\$43.6 million	\$6.1 million	\$5.5 million

Table 4.

Sharing rule: Company 70%, Province 30%

<i>Margin</i>	<i>Initial Fund Size</i>	<i>PV to Company</i>	<i>PV to Province</i>
0%	\$33.5 million	\$3.6 million	-\$3.2 million
10%	\$36.9 million	\$3.8 million	-\$1.4 million
20%	\$40.2 million	\$4.6 million	\$2.6 million
30%	\$43.6 million	\$2.7 million	\$7.8 million

The most important results demonstrated by these simulations are:

- In terms of the effect on the Province there is a distinct tradeoff between the margin percentage and the share of surpluses going to the Province.
- To limit the Province's position to approximately zero requires either a 30% margin (i.e. \$43.6 million initial Fund size) if 100% of surpluses are paid to the company or a margin between 10% and 20% (i.e. \$ initial Fund size between \$36.9 and \$40.2 million) if the Province receives 20% or 30% of the surpluses.

We note that, while the Fund accounts for the risk that must be born, it does not eliminate risk. Table 5 illustrates this by presenting the 90% confidence interval for the Government and the Company.

Table 5.

<i>Margin</i>	<i>Percent of Surplusses Paid to Government</i>	<i>90% Confidence Interval for the Present Values</i>	
		<i>to the Government</i>	<i>to the Company</i>
10%	20%	-\$33 m - \$18 m	-\$2 m - \$18 m
10%	30%	-\$40 m - \$19 m	-\$3 m - \$15 m
20%	20%	-\$29 m - \$24 m	-\$2 m - \$21 m
20%	30%	-\$27 m - \$23 m	-\$1 m - \$18 m

3.8 Example of Two Cost Scenarios

In order to illustrate how the Fund would operate and to demonstrate the role of the required margin above MCV, we examined two particular mitigation cost scenarios. In the first scenario mitigation costs are significantly higher than expected: during the first five years the annual cost rises steadily from \$1.00 million to \$1.50 million and then remains at \$1.50 million thereafter. Mitigation costs in the second scenario are significantly below expectations: the annual cost falls steadily from \$1.00 million to \$0.50 million and then remains constant. In order to focus on the effects of mitigation cost realizations, we assumed for both scenarios that realized rates of return exactly followed the forecasts on which the MCV is based. In other words, the only surprises that occur in the scenarios are the realized mitigation costs.

Table 6 shows results for 1993 through 1999 in the high cost scenario for the case of a Fund with zero margin. Beyond 1999 the annual mitigation cost remains \$1.50 million. The column labelled "MCV+0% margin" shows the required Fund size at the end of each year after that year's mitigation cost is paid. The MCV for that year is calculated on the assumption that

future mitigation costs will remain at the level of the cost realized that year, In other words, in each of the years 1994 through 1998 expected future costs are re-evaluated upward as the cost realized that year exceeds the previous year's expectation. From 1999 onwards realized costs match the previous expectations.

The column labelled "Fund" shows the Fund balance each year after realized investment income is received and realized mitigation costs are paid. The excess or deficiency of the realized Fund balance relative to the required Fund size (MCV plus margin) is shown in the column labelled "Surplus". A positive entry in this column indicates a surplus to be shared by the owner of the FOS and the Province; a negative entry indicates a deficiency that must be made up by a contribution of additional Funds by the company. From 1999 onward the annual surplus is constant. In order to examine the incentives of the owner of the FOS to contribute additional Funds where required, the column labelled "FOS" shows the value of the entire FOS (i.e. ignoring any sharing rule) assuming all previous years' surpluses have been paid out and deficiencies paid in but before action has been taken on that year's surplus or deficiency.

The effect of zero margin when realized mitigation costs exceed expectations is clearly seen in Table 6. At the end of 1994 there is a deficiency of \$3.79 million in the Fund. With zero margin the FOS (ignoring sharing rules) is always equal to the surplus/deficiency, so in 1994 it is also a negative

\$3.79 million. This means that the financial incentive for the company is to give up ownership of the FOS rather than contribute additional Funds. If this occurs, the Province takes over the FOS, pays that year's deficiency and pays or receives all future deficiencies or surpluses. For the cost scenario in Table 6, if the company were to give up the FOS at the first date when there is a financial incentive to do so (i.e. 1994), the additional payments made by the Province to cover deficiencies in the Fund have a total present value as of the inception of the Fund (i.e., the end of 1988) of \$15.48 million.

Table 7 shows results for the same mitigation cost scenario as in Table 6 but for a Fund that includes a 10% margin above MCV. What is apparent from the "FOS" column in Table 7 is that the owner of the FOS has each year in which there is a deficiency a financial incentive to contribute the additional funds required that year rather than relinquish ownership of the FOS. (The 1994 "FOS" value of \$0.00 million indicates a breakeven situation with respect to retaining ownership of the FOS.) Since the company has a financial incentive to make the required payments to cover deficiencies in the Fund, the Province does not have to bear the unforeseen extra mitigation costs. This is in contrast to the situation in Table 6 and shows the importance of the margin above MCV in the operation of the Fund.

Tables 8 and 9 show results for 1993 through 1999 for the scenario in which realized mitigation costs fall below expectations. Table 8 is for the zero margin Fund considered in Table 6 and Table 9 is for the 10% margin

Fund considered in Table 7. Tables 8 and 9 show how the revision of cost expectations as realized costs fall below previous expectations leads to surpluses that are paid out to the owner of the FOS and the Province according to some sharing rule.

The significant conclusion that emerges from consideration of Tables 6, 7, 8 and 9 together is that the inclusion of a positive margin above MCV greatly reduces the Province's exposure to bearing the effects of higher than expected mitigation costs because the margin significantly affects the financial incentive of the company to contribute required additional funds rather than give up ownership of the FOS. When mitigation costs turn out to be lower than expected, on the other hand, the inclusion of a positive margin merely increases the positive surpluses that will be paid back to the company.

Table 6

<i>Year</i>	<i>Cost</i>	<i>MCV+0% Margin</i>	<i>Fund</i>	<i>Surplus</i>	<i>FOS</i>
1993	\$1.00 m	\$37.03 m	\$37.03 m	\$0.00 m	\$0.00 m
1994	\$1.10 m	\$40.63 m	\$36.84 m	-\$3.79 m	-\$3.79 m
1995	\$1.20 m	\$44.21 m	\$40.43 m	-\$3.78 m	-\$3.78 m
1996	\$1.30 m	\$47.77 m	\$44.00 m	-\$3.77 m	-\$3.77 m
1997	\$1.40 m	\$51.55 m	\$47.55 m	-\$3.77 m	-\$3.77 m
1998	\$1.50 m	\$54.83 m	\$51.07 m	-\$3.76 m	-\$3.76 m
1999	\$1.50 m	\$54.67 m	\$54.67 m	\$0.00 m	\$0.00 m

Table 7

<i>Year</i>	<i>Cost</i>	<i>MCV+10% Margin</i>	<i>Fund</i>	<i>Surplus</i>	<i>FOS</i>
1993	\$1.00 m	\$40.73 m	\$40.83 m	\$0.10 m	\$3.80 m
1994	\$1.10 m	\$44.69 m	\$40.63 m	-\$4.06 m	\$0.00 m
1995	\$1.20 m	\$48.63 m	\$44.59 m	-\$4.04 m	\$0.38 m
1996	\$1.30 m	\$52.55 m	\$48.53 m	-\$4.02 m	\$0.75 m
1997	\$1.40 m	\$56.44 m	\$52.44 m	-\$4.00 m	\$1.13 m
1998	\$1.50 m	\$60.31 m	\$56.33 m	-\$3.98 m	\$1.50 m
1999	\$1.50 m	\$60.14 m	\$60.29 m	\$0.15 m	\$5.62 m

Table 7

<i>Year</i>	<i>Cost</i>	<i>MCV+0% Margin</i>	<i>Fund</i>	<i>Surplus</i>	<i>FOS</i>
1993	\$1.00 m	\$37.03 m	\$37.03 m	\$0.00 m	\$0.00 m
1994	\$0.90 m	\$33.24 m	\$37.04 m	\$3.79 m	\$3.79 m
1995	\$0.80 m	\$29.47 m	\$33.26 m	\$3.78 m	\$3.78 m
1996	\$0.70 m	\$25.72 m	\$29.50 m	\$3.77 m	\$3.77 m
1997	\$0.60 m	\$21.99 m	\$25.76 m	\$3.77 m	\$3.77 m
1998	\$0.50 m	\$18.28 m	\$22.03 m	\$3.76 m	\$3.76 m
1999	\$0.50 m	\$18.22 m	\$18.22 m	\$0.00 m	\$0.00 m

Table 9

<i>Year</i>	<i>Cost</i>	<i>MCV+0% Margin</i>	<i>Fund</i>	<i>Surplus</i>	<i>FOS</i>
1993	\$1.00 m	\$40.73 m	\$40.83 m	\$0.10 m	\$3.80 m
1994	\$0.90 m	\$36.57 m	\$40.83 m	\$4.26 m	\$7.59 m
1995	\$0.80 m	\$32.42 m	\$36.66 m	\$4.24 m	\$7.19 m
1996	\$0.70 m	\$28.30 m	\$32.52 m	\$4.22 m	\$6.79 m
1997	\$0.60 m	\$24.19 m	\$28.39 m	\$4.20 m	\$6.40 m
1998	\$0.50 m	\$20.10 m	\$24.28 m	\$4.18 m	\$6.01 m
1999	\$0.50 m	\$20.05 m	\$20.10 m	\$0.05 m	\$1.87 m